

Characterization of the Atmospheric Aerosols in the Buenos Aires area using long term Sun Photometer Measurements.

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ABSTRACT. An analysis of aerosols optical parameters is conducted using the sun photometer measurements taken at CEILAP in 2000. The sun photometer deployed in the Buenos Aires suburb is part of AERONET (Aerosol Robotic Network). Using the present data set, time series of key optical parameters such as the optical depth at 500 nm and Angstrom coefficient of the wavelength scaling law are derived. Clustering the observations by the mean of a statistical analysis we can infer the pollution episodes in the Buenos Aires area. They can be either of local or regional origins, depending on the meteorological conditions prevailing over central Argentina.

1. INTRODUCTION

Aerosols optical variabilities in time and space and their relations with air masses identification is a key issue to air quality problem. It may involve local sources and regional contributions[1]. In climate studies, the results of simulation using radiative transfer model show a strong dependence with aerosols content in particular in the lower troposphere with significant optical depths. Accurate remote sensing by satellite of the biosphere and biosphere-atmosphere interaction requires to know the atmospheric transmission at different wavelengths to assess a vegetation index which is used in global change monitoring [1,5].

The photochemical production during pollution episodes is strongly influenced by the presence of tropospheric aerosols and their temporal and spatial variabilities associated to different atmospheric scales. As a results, the aerosols burden modify the atmospheric turbidity and optical properties. The pollution episodes in the Rio de la Plata basin are correlated with air stagnation. The air masses in central Argentina are governed by large scales processes, and are generally referred as subtropical when coming from the Amazonian forest, or as polar continental or polar maritime when they originate from southern Argentina or southern Atlantic ocean. The air masses in central Argentina are also influenced by meso scale processes involving low level jets and regional winds known as “Sudestadas” and “Sudoestadas”. [1,2,6]

Indeed, a research program devoted to Air Quality in the Buenos Aires area has to consider the relevance of all atmospheric scales on the tropospheric aerosols characteristics. The studies conducted in the framework of AERONET have shown the relevance of long term sunphotometer measurements at various locations [2]. As new contributor to AERONET, we conducted a study on the relevance of the data recorded at CEILAP to air pollution issues, with links to heat island effect and air mass modification associated to meso-scale circulation pattern in the Rio de la Plata basin. Sunphotometer measurements at different wavelengths are analyzed to outline periods of large modification in aerosols optical parameters. The analysis is based on modal characteristics of the frequency distribution. Identification of air mass modifications and their influences on aerosols characteristics are conducted by clustering of monthly variability.

2. DATA PROCESSING

Aerosols optical depth measurements were performed by a sun photometer deployed at CEILAP in Buenos Aires suburb (34° 34'S, 58° 30'W) during twelve months from January through November, 2000. CEILAP is located nearby an active industrial zone and it is under to the strong influence of the Rio de la Plata. In addition, central Argentina is under the influence of Amazonian forest fires and seasonal bio mass burning events depending on the synoptic conditions.

The sun photometric techniques is described in [4]. It yields to errors in optical depth which do not exceed ± 0.01 . The sun photometer instrument at CEILAP is equipped with five interference filters centered at 1020 nm, 940 nm, 670 nm,

500 nm, 480 nm and 430 nm. One channel : 940 nm match the water vapor absorption band. The four remaining channels do not match any significant molecular absorption band, and so can be used to retrieve the aerosols optical depths. The interference filter bandwidths range between 5 to 10 nm.

The scaling law which represents the optical depth spectral dependence is : $\delta = \beta \lambda^{-\alpha}$, where α is the Angstrom coefficient, β the air turbidity and λ the wavelength. The Angstrom coefficient is computed by a linear fitting of the data as follow $\alpha = -\frac{d[\ln(\delta)]}{d[\ln(\lambda)]}$. Time series of δ at 500 nm and α are derived after a cloud screening is applied on the data sets

[4]. The optical depth around 1200 GMT is used as a significant atmospheric parameter in correlation with the maximum downward solar flux at the ground.

3. DATA ANALYSIS AND RESULTS

A statistical analysis was performed to calculate the monthly mean values for the two first moments of the distributions of δ and α , as mentioned above. The annual trend of these two parameters display a significant increase toward the austral winter and spring seasons as shown in Table 1. As a confirmation of this signature we shows below the seasonal clustering of these two quantities.

Table 1 : Data for one year period in 2000. Values of aerosol optical depth at 500 nm and Angstrom coefficient. Monthly mean values and standard deviations calculated in the timeframe from 1100 to 1300 GMT.

	Days of the month	$\bar{\delta}/\sigma_{\delta}$	$\bar{\alpha}/\sigma_{\alpha}$
Jan.	3/7	0.05/0.03	0.60/0.36
Feb.	17./23	0.09/0.04	0.85/0.43
March	23/27	0.09/0.05	0.80/0.35
April	13/15	0.08/0.03	0.97/0.28
May	14/17	0.09/0.05	1.05/0.21
June	8/14	0.08/0.03	0.94/0.28
July	16/18	0.10/0.12	1.04/0.41
Aug.	21/24	0.15/0.09	1.20/0.36
Sept	17/20	0.15/0.12	1.06/0.28
Oct	20/22	0.16/0.08	0.95/0.31
Nov.	8/9	0.12/0.03	0.66/0.35
Year	160/196	0.11/0.03	0.92/0.18

Seasonal Characterization of optical depth and Angstrom coefficient.

Seasonal clusterings are performed using the daily means values of δ and α . The natural variability of aerosol optical depth which is associated to atmospheric micro scale phenomena has a contribution of $\delta=0.11$. According to the Fig. 1 the austral seasons show increased values of optical depths in winter and spring. This modification can be attributed to the influence of polar continental and maritime air masses. Air mass modification in different seasons can be traced by the mean of the Angstrom coefficient distribution.

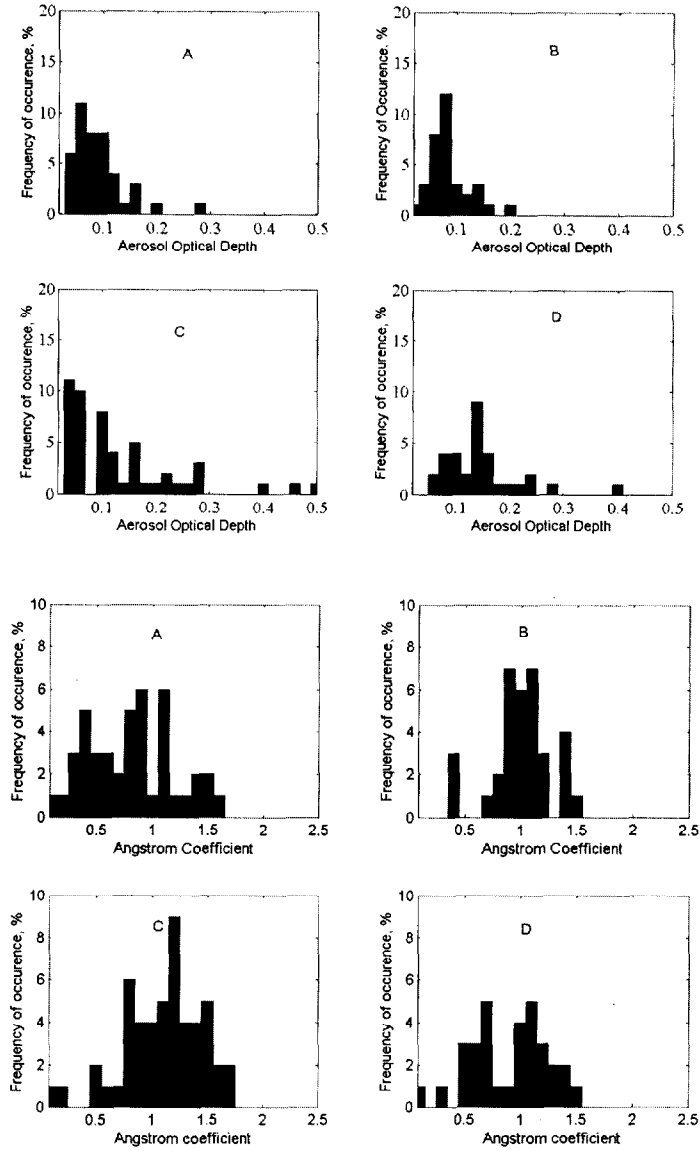


Figure 1. Seasonal occurrence of aerosol optical depth at 500 nm (top panel) and Angstrom coefficient (bottom) for Summer (a), Autumn (b), Winter (c) and Spring (d). The sum of all frequencies (%) is equal to 100%.

Analysis of regional and micro scale contribution

A statistical analysis considering the variability of δ at 500 nm and α is performed to extract the number of events (or periods) affected by polluted air masses transported at the regional scale. We can identify the relevant episodes considering the deviation of each parameter from the monthly mean value. We consider the urban aerosols content is in a steady state regime with no major interruption associated to vacation or major accident. For the micro scale we consider small standard deviation : $|\delta - \bar{\delta}| < \sigma_{\delta}$, and for regional scale process large standard deviation : $|\delta - \bar{\delta}| > \sigma_{\delta}$. With this criteria we identified in Table 2 the number of measurements affected by regional scale processes (or long range transport).

Table 2. Statistical analysis in terms of monthly occurrence of cases with high dispersion samples.

	Days/Series	$ \delta - \bar{\delta} > \sigma_{\delta}$	$ \alpha - \bar{\alpha} > \sigma_{\alpha}$
Jan.	3/7	1	1
Feb.	17./23	3	7
March	23/27	4	7
April	13/15	3	3
May	14/17	3	5
June	8/14	4	2
July	16/18	2	4
Aug.	21/24	7	7
Sept	17/20	1	6
Oct	20/22	5	7
Nov.	8/9	3	3

The number of events with optical depth and/or Angstrom coefficient off by one-sigma in the monthly analysis in comparison with the total number of cases reveal an influence of non local contribution. We have correlated our statistical analysis with different events that occurred in the Rio de la Plata basin. As an example we report on the regional intrusion of a large forest fire taking place some 200 km away from Buenos Aires in the north direction as referenced in [3] on 17 and 18 March 2000. The air masses is coming from north-east associated to an low pressure. It resulted in low visibility condition in the Buenos Aires area. On this occasion, the optical depth reached a value of 0.3 in UV domain and near 0.2 in the visible domain.

4. CONCLUSION

Using the data set collected during one year, the atmospheric aerosols content over the Buenos Aires area have been characterized by the optical depth at 500 nm and the Angstrom coefficient. Both, the optical depth and Angstrom coefficient are retrieved by a linear fitting procedure. It is worth to point out that other techniques like a parabolic fit [2] can be used in order to more precisely identified the behavior in the near infrared or in the near uv spectral domain. Concerning the clustering technique to identify the regional influence on the optical properties, it would be useful to complement the present analysis with synoptic meteorological analysis and back trajectories analysis to better identify the air mass origin. This is left to future works. From the present analysis we can clearly identify the time periods where the optical depth shows an increase of its statistical mean value, associated to a natural variability, and contributions from mesoscale. Utilizing the statistical distribution of δ and α we see that Autumn is affected by local processes, whereas the other seasons around the year are influences by regional processes. From our analysis, it is possible to identify mid Summer to Autumn to study photochemical pollution in Buenos Aires, while other periods of time are more suited to study regional transport such as forest fire and biomass burnings.

5. REFERENCES

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